Upscaling Energy Related Innovations

ISandick, E.
TNO Built Environment and Geosciences, the Netherlands
(email: emma.vansandick@tno.nl)
Mieke Oostra, M.
TNO Built Environment and Geosciences, the Netherlands
(email: mieke.oostra@tno.nl)

Abstract

Awareness that fundamental change is necessary regarding our CO_2 output as society has never been higher, as is reflected by results of IPCC, IEA and UFCCC. Governments, as well as local municipalities, are formulating targets in order to diminish energy usage and/or CO_2 emissions. Since 40% of energy usage is related to the built environment, it is an area where important contributions are made and should be made. To be able to achieve the ambitions of major CO_2 reductions the EU has set, energy efficient innovations and concepts need upscaling. In this paper an inventory was made of the possibilities to influence the process of upscaling, as perceived by actors experienced with complex energy related innovations. This consists of an overview of the possibilities of different commercial parties in the building industry and professional clients. In a parallel study possibilities were studied of governmental actors, who are able to define policy instruments. This multi-faceted approach was chosen to reflect on ways to stimulate upscaling, in which the activities of all parties should be included. The inventory presented in this paper is made in relation to energy efficient building concepts, both reducing the total amount of energy used and replacing fossil energy with sustainable energy sources. This topic is chosen due to its urgency and its complexity. Several measures and products have to function together in an integrated approach in order to reach the performance levels required. The research method was a combination of desk research, test sessions and interviews. From this study conclusions will be drawn on the possibilities different parties have for stimulating upscaling energy efficient concepts. Finally some reflections on the results will be added.

Keywords: upscaling, energy, transition management, innovation management

1 Introduction

Important parties and organisations worldwide are underlining the urgency to prevent further increase of CO_2 levels in our atmosphere, in order to prevent global warming (e.g. IPCC 2007, IEA 2008, UNFCCC 2002) and its dramatic consequences. In correspondence with these outlines, other parties and organisations formulated ambitious goals to reduce the use of fossil energy in the built environment (e.g. WBCSD 2004, 2005, 2007, NSTC 2008). The EU aims at an energy neutral built environment in 2040. To fulfil these goals there is an acceleration needed in the process of bringing energy efficient innovations in construction in the phase of full implementation. The built environment contributes about 40% to the emmisions of CO_2, produced especially by operating the older buildings in the existing building stock (WBCSD 2004).

In the construction sector a lot of products and technologies were developed in the last 40 years with the goal to improve the energy efficiency of the built environment. Examples of these innovations are heat pumps in combination with aquifers, geothermal heath, insulation, solar thermal combinations, the application of PV cells on buildings etc. To reach ambitious levels of energy reduction these innovations should be applied in combination with each other. This makes the process of implementation of these innovations complex. At the moment these innovations are applied in demonstration projects and small scale projects. The application on a large scale lags behind expectation, as are activities that complement these new techniques in order to turn them into mainstream business practices. This context of the implementation of these kinds of innovations is the focus for this research because of its urgency and its complexity.

The process in which broad implementation of an innovation is achieved, is called upscaling. In this process the innovation evolves from a niche solution towards a mainstream solution. This means all parties have to become familiar with the benefits of the innovation and have to develop know how on its use and application. In general this leads towards a change of competences and habits of people involved. It also means that all infrastructure has to be put in place and all institutions have to be aligned for mainstream application.

The process of upscaling is known to require long periods of time, taking at least several decades (Bosch 2009). This is especially true for more complex and rigorous innovations, since these types of innovation demand drastic change on several aspects. An example of such an innovation is the alteration of the building production from handy craft towards industrialisation, in which building components will be machine produced. This way of working has influenced the entire value chain in the construction sector. New (combinations of) building materials were used, the organisation of the work was altered (specialisation of activities), production activities relocated from production on site, to production off site in the factory and the knowledge and skills needed by professionals changed accordingly. The upscaling of this new way of working was a process in which a lot of parties were and are still involved. After WW II industrialisation in construction was stimulated with special programs by different governments in order to rebuild the building stock deteriorated during the war (e.g. the Netherlands and Sweden). In this case the process has taken more than several decades. One could easily argue this process of upscaling is still evolving (e.g. see development as described in Girmscheid 2010).

For the innovations we are discussing in this paper we expect even more difficulties in the process of becoming mainstream. The activities needed to overcome the barriers for upscaling towards zero energy building are more difficult to overcome by the parties from the building sector without support from the policymakers, since they are meant to serve society as a whole, with some possible direct benefits for end-users. The market cannot be expected to act automatically in line with this apparent need from society as a whole. Policy making and regulations are therefore necessary ingredients in order to be able to achieve the required goal.

Before we go on, we want to stress that the process of upscaling of innovation is not a smooth and easy process. It is more like a bumpy road with a lot of roadblocks and unexpected holes. A lot of innovations never reach their destination over this bumpy road. It is therefore risky and you cannot guarantee the outcomes when influencing these processes. Innovation processes in the building sector are known to be difficult as it is. Due to fragmentation of the sector, strong regulation, extreme focus on price these processes are even more difficult than in other sectors. In paragraph 3.1 we give an overview of the barriers that can be found for the construction sector.

To better understand the mechanisms that influence the process of upscaling we use the concept of innovation systems. An innovation system is the combination of actors, institutions and infrastructures that interact and shape the conditions for innovations to develop. The dynamics of an innovation system can be understand by analyzing the different functions of the innovation system as defined by Hekkert and others (e.g. Hekkert 2008, Suurs 2009)

In this paper an inventory was made of the possibilities actors in the building industry perceive to have for influencing the process of upscaling. This includes an overview of the possibilities as perceived by the different commercial parties and professional clients, as addressed in this paper. In a parallel study possibilities are studied of governmental actors, who are able to define policy instruments. This approach was chosen while in order to realise upscaling the activities of all parties should be included.

The inventory in this paper is made in relation to energy efficient building concepts, both reducing the total amount of energy used and replacing fossil energy with sustainable energy sources. In this study parties involved in the application of concepts, like passive house were regarded. This is a concept in which the consumption of fossil energy is dramatically decreased towards a level of annual heating requirement that is less than 15 kWh/(m²a) (4755 Btu/ft²/yr), not to be attained at the cost of an increase in use of energy for other purposes (e.g., electricity). Furthermore, the combined primary energy consumption of living area of a European passive house may not exceed 120 kWh/(m²a) (38039 Btu/ft²/yr) for heat, hot water and household electricity (www.passiv.de, Feist 1993). Concepts like passive house are seen as important steps towards a built environment which is energy neutral. There have been some discussions about the definition of zero energy buildings and their impact (Torcellini 2006a, 2006b, Rovers 2008). For this study parties with experience with passive house projects and other complex energy concepts were interviewed. The innovation level of these projects had to require multiple measures, for example insulation in combination with improved air tightness, controlled ventilation, low temperature heating, heat pump, etc. Multiparty involvement on design and realisation was another criteria as well as a high impact on energy reduction, with a minimum of a

40% reduction of fossil energy consumption. Concepts in line with these criteria will be referred to as energy efficient concepts.

This criterium for energy efficient concepts ensured that parties who were interviewed had been involved in ambitious projects in which the problems accumulate that need to be solved to make a breakthrough in energy efficient building. The parties in the value chain should cooperate in order to achieve these ambitions. The current status in the Netherlands is that in some area's one pilot house is built or pilot projects are realised with a maximum of dozens of houses. The amount is growing, but it is still at an early stage of upscaling.

1.1 Research question and method

The central research question for this paper is as follows: What opportunities do parties in construction have to upscale the energy efficient building concepts in the Dutch context?

Sub questions in this research were:

- What barriers are there to up-scale innovations related to energy efficient building concepts?
- What roles do different parties in construction see for themselves and which of those do they take on already?
- What opportunities are still left to influence further implementation by other parties in the perception of the interviewees?
- What can we conclude on the opportunities of parties to influence the up-scaling of energy efficient building concepts in general in the Netherlands?

The research method was a combination of desk research, test sessions and interviews. The desk research was carried out in order to construct a theoretical framework to investigate up-scaling and determine barriers to innovation in construction already collected in other studies. The theoretical framework was tested in two sessions with project leaders of complex innovation processes (Oostra 2008). Furthermore, during the summer and early authum of 2009, different actors in the field were interviewed about the interventions they make to forward the energy efficient concepts. They were asked as well what possibilities they saw for other actors to intervene and finally what barriers they encountered.

The reason to limit the implications for this study in this paper to the Netherlands, is the fact that context in the different countries will differ due to differences in policies, even if they respond to similar preconditions as formulated by the European Committee in order to reduce fossil energy consumption in the built environment. More research will be necessary to validate the results for other countries.

2 Theoretical framework

In principle, all parties involved in construction have their own possibilities to influence up-scaling. A general model was developed which can be used for different actors. This model is used as way to reflect with project leaders on up-scaling (Coenen 2008). The model also served as a basis to develop the main steps to design a new policy strategy, which are shown the figure below (figure 1).

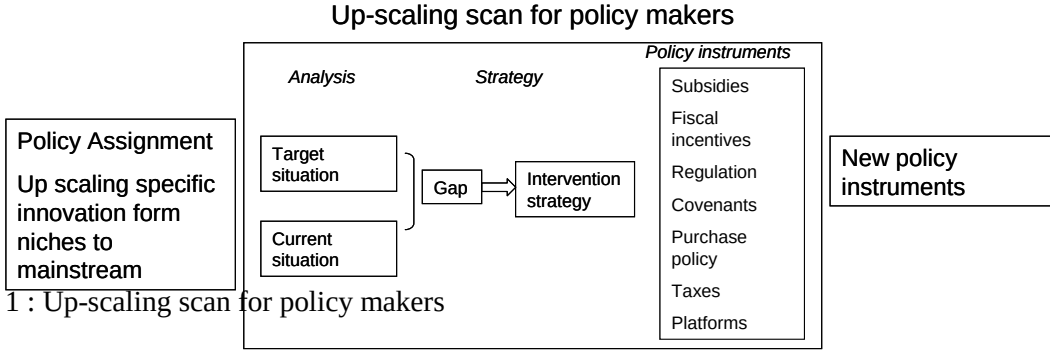

Figure 1 : Up-scaling scan for policy makers

As was argued in the introduction, the concept of innovation system was used for the purpose of analysing the drivers and barriers for up-scaling of innovations. Different frameworks were used to execute this analysis. The first is the System Innovation Policy Framework (Freeman 1995). Klein Woolthuis (e.g. Klein Woolthuis 2005) developed it to analyse the different elements of the framework, as well as to compare the elements in the current situation with the goal situation. For the purpose of this paper the goal situation is the situation in which the innovation is scaled up. The System Innovation Policy Framework distinguishes between the following elements: infrastructure, institutions, interactions, capabilities and market structure.

Infrastructure	Physical infrastructure, products
Institutions	Hard (laws, regulation) and soft (norms, values, implicit rules of the game)
Interactions	To strong or to weak interactions
Capabilities	Entrepreneurship, adequate labour qualifications and the like
Market structure	The way the market is structured and organised

By systematically analysing the different elements a clear view will emerge as to what barriers remain for upscaling.

In order to include the current dynamics of the innovation system, the System Innovation Policy Framework was combined with the functions of innovation systems as developed by Hekkert and others (e.g. Hekkert 2008, Suurs 2009). The functions used in the analysis were the following:

Table 1: Functions of technological innovation systems.

System Function	**Description**	**Event types associated**
F1. *Entrepreneurial Activities*	The role of the entrepreneur is to translate knowledge into business opportunities, and eventually innovations. The entrepreneur does this by performing market-oriented experiments that establish change, both to the emerging technology and to the institutions that surround it.	Projects with a commercial aim, demonstrations, portfolio expansions
F2. *Knowledge Development*	This function involves learning activities, mostly on the emerging technology, but also on markets, networks, users etc. Learning activities relate to both learning-by-searching and learning-by-doing. The former concerns R&D activities, whereas the latter involves learning in a practical context.	Studies, laboratory trials, pilots
F3. *Knowledge Diffusion*	Innovations occur most where actors of different backgrounds interact. A special form of interactive learning is learning-by-using, which involves learning activities based on the experience of users.	Conferences, workshops, alliances
F4. *Guidance of the Search*	This function refers to the activities that shape the needs, requirements and expectations of actors with respect to their (further) support of the emerging technology.	Expectations, promises, policy targets, standards, research outcomes
F5. *Market Formation*	Emerging technologies cannot be expected to compete with incumbent technologies. To support innovation, it is usually necessary to create artificial markets. This involves activities that contribute to the creation of a demand for the emerging technology.	Market regulations, tax exemptions
F6. *Resource Mobilisation*	This function refers to the allocation of financial, material and human capital. The access to such capital factors is necessary for all TIS developments.	Subsidies, investments
F7. *Support from Advocacy Coalitions*	The rise of an emerging technology often leads to resistance from actors with interests in the incumbent energy system. In order for a TIS to develop, other actors must counteract this inertia. This can be done by urging authorities to reorganise the institutional configuration of the TIS.	Lobbies, advice

The functions of innovation systems were used to plot the activities that are taking place in the innovation system with the purpose to implement energy efficient concepts. The functions were also used to categorise the activities mentioned in the interviews. This analysis formed the basis to make an inventory of the strategic gap for upscaling energy efficient concepts.

3 Results

In this section results from theory will be combined with results from the interviews in order to identify barriers for upscaling.

3.1 Barriers for innovation from the literature

There have been quite a few studies on barriers to innovation in construction in general. These barriers appear to be valid for energy efficient concepts as well. Kulatunga ea (2006) have made an inventory on the barriers described in construction innovation literature:

- Fragmentation of the industry (Pries and Janzen 1995) and professional bodies (Winch 1998).
- Isolation and distance between contractors and consultants (Gann 2000).
- Significant coordination and integration problems due to extreme specialisation of functions and/or involvement of various professions (Nam and Tatum 1997).
- Risk aversion due to the long life span of the construction products (Blayse and Manley 2004, Nam and Tatum 1997).
- Opportunities to be innovative are restricted due to technical regulations (Blayse and Manley 2004; Veshosky, 1998). Pries (1995, p: 45) Bowle (1960, cited in Ling, 2003)
- Undue emphasis on cost-cutting measures, economic recession and lowest bidding practice that impeded the actual ability of parties to innovate. (Dulaimi 2005, Veshosky 1998)
- Innovation goes against organisational and industry culture (Veshosky 1998)

3.2 Analysis structure of the innovation system

The first step in our analysis was to clearify the goals to be set for the different system characteristics in order to reach the upscaling of energy efficient concepts. In the interviews with representatives from the building sector we discussed what the goals should be. Interviewed were people from a service provider, a builder, a project developer, a producer of insulation, a producer of heat pumps, a

trade organisation of professional clients and an advisor on sustainable buildings. The people chosen were front runners and all had experience with Passive House or other energy efficient concepts.

The results were combined with the results from two workshops with project teams to systematically analyze what possibilities parties have to influence energy efficient innovations (Oostra 2008).

Table 2: overview of the strategic goals to overcome the barriers and develop opportunities for upscaling

System Characteristic	**Strategic Goals**
Infrastructure	1. Products developments (plug & play, user-friendly, total solutions, 'killer'add-ons, product-service combinations) 2. intelligent energy net suitable for connecting sustainable solutions 3. solid knowledge base in the value chain 4. production and distribution facilities
Institutions	5. Consistent and reliable policy 6. Policy on total costs for housing in stead of rent + energy costs 7. Policy for market creation in the current building sector (regulation, financial incentives) 8. Process of user acceptance (awareness, knowledge, interest, transparency of the costs, risk reduction) 9. Reframing of current framework and habits (transforming the current idea fossil energy is an endless source)
Interactions	10. User participation in building processes 11. Cooperation across the value chain 12. Familiarize people with possibilities and usage (fairs, model homes) 13. Learning sector and society (a problem with an innovation does not legitimise political action to kill it)
Capabilities	14. Combination of technological skills with organisational and commercial skills across the value chain 15. Developing from production sector towards service oriented sector
Market structure	16. Market creation by setting targeting ambitious targets for new buildings 17. Market creation for current building (taxes, etc) 18. Financial constructions to solve current split incentives (split between investor and benefits for end-user, un-balance between investment costs and return on investment, split between budgets for initial investment costs and maintenance & operation costs)

As indicated earlier, the theory of the functions of the innovation system was used as a framework to generate an overview of the current situation of the innovation system and its dynamics. An inventory was made of the activities that already take place in the innovation system. All sorts of activities have been initiated to develop the different functions. As a result there are different energy efficient

concepts emerging in Dutch construction. Parties are organizing themselves around concepts (e.g. passivehouse.nl), and value chains (e.g. E.nu). A lot of effort from front runners is being put in disseminating information towards potential clients (e.g. websites, trade markets) and value chain partners. On the other hand governement is trying to stimulate initiatives with special programs (e.g. PeGO, EOS), subsidies (e.g. SDE) and tax measures (e.g. insulation). The inventory of activities is step one in the gap analysis. A general overview of the results can be found in table 4 in the appendix.

3.3 Possibilities of parties to accelerate upscaling

Representatives of the different parties in construction were also interviewed to make an inventory of the possibilities they see to accelerate the process of upscaling. In the appendix a table is presented were a general overview is given of the possibilities parties saw as roles for themselves and roles for other parties (table 5). From analyzing this data we conclude the following:

Entrepreneurial activities:
Frontrunners are very active with energy efficient concepts. These organizations see the necessity to align their products and measurements with others, which requires cooperation. They do see possibilities for cooperation with other parties, but the realisation remains difficult due to the fragmented nature of the building sector. On the other hand existing cooperations, like the Passive House initiative in the Netherlands, is felt to exclude the possibility to cooperate with other parties outside the initiative. To include the next group of entrepreneurs in energy efficient concepts, it is necessary to develop market perspective.

Knowledge development:
Knowledge development should be aimed at the development of products and concepts in which different solutions are combined. This means new fundamental knowledge is not so much required as is the combination of existing knowledge.

Knowledge diffusion:
A lot of emphasis is put on the necessity to disseminate information and knowledge that is already available. Most of the effort of the different parties is to be put in this category of activities. Activities parties take on themselves and see as a role for others are in fact quite similar for knowledge development and knowledge diffusion. One could draw the conclusion these activities are regarded as pivotal in the eyes of the different parties. There is also a need for a more independent source of information in order to legitimate their products and services.

Guidance of the search:
Given the amount of different suggestions for guidance of the search, there is a certain need for direction. Since the interviews were are all from representatives of market parties, and not with policymakers, it is logical a role for policy makers is emerging in guidance of the search. The type of measurements suggested for guidance of the search can be categorized as activities required for market creation. In general parties conclude there is no real sense of urgency felt in society. They feel government, media and independent parties should take their responsibility in order to help to change this. Policy makers are seen as important factors in creating general awareness among the public and

in defining the level of ambition. The best part of their own role is seen in communication towards the market. This in itself is probably not enough to create market for all different niches in construction. There is also a need to objectify the impact of the solutions different parties are proposing.

Market formation:
The split incentive for those likely to pay for energy saving measures and those benefiting from the use of energy saving measures is seen as a problem. No easy solutions are discovered yet. Some niche markets do not have such a split incentive, however. These are the niches markets where the owner is the same party as the user(s) of the building. Clients in these markets are the easiest to convert e.g. the client-users of commercial buildings and client-users of dwellings. In private owned dwellings there is the problem of the long pay-back time. Home owners are not willing to invest in improvements that have a pay-back time that is longer than the period they expect to live in the dwelling. In general the EPC regulation is stimulating market formation since it is clear for the parties what is the norm.

Resource mobilisation:
It is remarkable no activities emerged for the resource mobilization dimension. This can be an indication commercial parties realise government is restricted in its means. Apparently there is no direct need for extra funding, although suggestions are made to create incentives in the form of increasing norms for regulation, applying tax measures and providing guarantees for a good feed-in tariff, similar to Germany, which will remain in place for the long term.

Support from advocacy coalitions:
General awareness and behaviour change is generally seen as the next big step in the reduction of energy consumption. But it is by no means clear how to address this with respect for individual decisions of consumers. How to deal with the freedom of choice for people in relation to a general change of behaviour required to meet ambitious energy reduction levels in the built environment? There is a need to discuss this topic and come to some sort of general consensus on how to approach these issues in the near future. This makes an excellent topic for advocacy coalitions.

3.4 Conclusions: Possible intervention for upscaling energy efficient building concepts

In table 3 the results can be found from the comparison made between the strategic goals (table 2) with the total of activities present in the current situation (table 4 in the appendix) and the activities that were mentioned in the interviews (table 5 in the appendix).

Table 3: overview of the possible activities as perceived by different parties structured along side the strategic goals necessary to upscale complex energy related innovations

System Characteristic	**Strategic Goals**	**Total of activities as mentioned by interviewees to be performed by themselves and others**

Infrastructure	1. Products developments (plug & play, user-friendly, total solutions, 'killer'add-ons, product-service combinations) 2. intelligent energy net suitable for connecting sustainable solutions 3. solid knowledge base in the value chain 4. production and distribution facilities	1. different initiatives although a lot of work remains 2. not addressed during interviews (although addressed by some actors, policy not yet in place) 3. widely addressed and a demand for support from policymakers 4. not addressed during interviews
Institutions	1. Consistent and reliable policy 2. Policy on total costs for housing in stead of rent + energy costs 3. Policy for market creation in the current building sector (regulation, financial incentives) 4. Process of user acceptance (awareness, knowledge, interest, transparency of the costs, risk reduction) 5. Reframing of current framework and habits (energy is an endless source)	1. The importance is recognized but remains a great challenge to make this reality 2. Idem 3. Is addressed during interviews, parties feel that more attention is required on this topic 4. Interviewees underline the importance of general awareness. 5. Still needs more work, there is a demand for support from media and policymakers
Interactions	1. User participation in building processes 2. Cooperation across the value chain 3. Familiarize people with possibilities and usage (fairs, model homes) 4. Learning sector and society (a problem with an innovation does not legitimise political action to kill it)	1. The importance is only partly seen by some parties, especially those from the demand site. This issue is only addressed partly with solutions / also reframing of end user necessary -> comfort and urgency of the fossil based energy consumption 2. Is seen and addressed by different parties, but is difficult to realize due the fragmentation of value chains 3. Is seen and addressed although more work is seen as necessary 4. Is addressed by some with chain integration, the other problem remains
Capabilities	1. Combination of technological skills with organisational and commercial skills across the value chain 2. Developing from production sector towards service oriented sector	1. Orientation towards organisational options is necessary since most inventors lack the commercial skills 2. Is not addressed by the interviewees. The authors expect this to be the next step in market development.
Market structure	1. Market creation by setting targeting ambitious targets for new buildings 2. Market creation for current buildings (taxes, etc) 3. Financial constructions to solve current split incentives (split between investor and benefits for	1. E.g. "Excellent Areas", current labels. But a strong stimulus for radical innovation is still required. 2. Extra effort will be needed. What will be acceptable measures in a time of deregulation? 3. Is experienced as a problem, solutions are investigated but still requires work

	end-user, un-balance between investment costs and return on investment, split between budgets for initial investment costs and maintenance & operation costs)	(no easy policy solutions)

Looking at the results of this research we can summarize some of the challenges for the building sector, its clients and policy makers for the upscaling of energy efficient concepts in the built environment. First conclusion would be that a wide variation of actions and measures is necessary to realise the upscaling of complex energy related innovations in construction. Based on the outcomes of this research the most important areas for extra effort for the sector itself would be the following:

On the part of knowledge dissemination, there is a lot of work remaining in the dissemination of why, what and how of the energy efficient concepts; towards different parties in construction, clients and end-users.

Another issue is the development of new products (plug & play, user-friendly, total solutions, 'killer'add-ons, product-service combinations) in combination with efforts for new business development for both new markets and new products (market creation) including a change towards a more service oriented sector. This will require more cooperation in the value chain, as is indicated, as well as a stronger knowledge base within the value chain and a learning sector. Intelligent grids and production facilities were not addressed during the interviews and are therefore out of the scope of this research.

From the side of policy makers incentives are required to stimulate radical innovation and measures to target existing buildings. In general there is demand for policy making that underlines market creation, this is accompanied by a strong plead for consistency in policy making and the formation of a learning society in which problems with new solution will not automatically lead to political discarding. A role is seen for both independent parties, among which policy makers, and media to underline the urgency of energy reduction and the change towards renewable energy sources towards citizens in general.

The great policy challenge is to create market for the more radical innovations in the new buildings. Especially if these would realize great reduction of fossil energy consumption, while not creating direct benefits for investors and end-users. Radical innovations are not easily implemented, which means parties in the chain naturally avoid these solutions. A strong stimulants combined with regulation can create a market for these innovative solutions. In the Netherlands an important precondition for any regulations would be the acceptability of new regulatory measures. A balance between market creation for energy related innovations and possible market disturbance of the housing market should be closely watched to keep interference acceptable. In the Dutch context the discussion or negotiating between parties (different pressure groups) to reach mutual agreement on the policy approach is necessary (Poel 2009).

Another great challenge is market creation for the current building stock. At the moment building owners are not very willing to invest, especially when they do not use the building themselves. The way present energy labels are implemented does not seem to effect the willingness tot invest. More stimulants (regulation and financial incentives) will be needed in order to create market. A growing or dormant market is a condition for developing new business cases, and it appears the current building stock can be regarded as such. Financial measures to solve the split incentive are needed. Or additional regulation or norms. The acceptance of regulation is of course also influenced by the sense of urgency building and house owners see to invest in energy efficient innovations. This could result in a situation where it is as normal to invest in energy efficient solutions as it is in a new kitchen. Communication can stimulate the emergence of a sense of urgency.

In general there seems to be a good understanding what actions and policy-interventions are needed. The greatest challenge is to coordinate these activities and to take care that actions are really taking place. This means cooperation between the different actors and between market parties and policy makers is necessary in order to align activities for upscaling. Cooperation in the building chain remains an important issue, as was already indicated in the list of the general barriers for innovation in the sector. The actors in the sector play a main role to accomplish this, although policy could support it.

The necessity to coordinate different actions means that a good method of monitoring and designing of the policy approach is needed. A policy approach is required with at the same time a long term horizon and flexibility on an instrumental level. Parties involved in this field (building sector, clients and policymakers) should be able to monitor their activities and adjust depending on the results and external developments.

4 Reflection on the results

The people involved were frontrunners, this means the picture of current activities derived from the research is more positive then can be expected from a general inventory of the sector as a whole. This makes the urgency for upscaling of energy efficient concepts ever more important.

How to handle upscaling remains a complex problem. All parties have their own contribution towards a more energy efficient built environment. No one seems to systematically align these contributions. Together these contributions will be able to realise upscaling. It is a familiar pitfall to suggest that by simply steering this process will lead to a favourable outcome. Yet it would help to:

- tune the different contributions. Not only among commercial parties or among different incentives and rules and regulations from policy makers, but also by bridging between the world of policymakers and building practice.

- have a method for monitoring and evaluation that would provide parties with feedback on how their actions are contributing and how effective they are. This will provide them with the opportunity to adjust and tune their activities, thereby enlarging chances of success in the upscaling process.

Since the fragmentation in the sector has been seen as a hindrance in the sector for years, one starts to wonder if reduction of fossil energy in buildings can be the trigger for real cooperation in the supply chain. Other questions that remain are what actions will work as an accelerator for other initiatives in the different niches, and what policy actions will stimulate these activities?

From the diversity of actions it becomes clear there are no simple answers on the question how to upscale energy related innovation. Clear is that a long-term perspective apart from current party politics is needed. Energy efficiency is a step to make the entire building sector more sustainable. Energy is however only one part of the problem. Yet the built environment could be expected to compensate for other fossil fuel addictions we have as society. It is likely the built environment should compensate for the energy consumption we require for personal mobility for example. One should carefully examine if policy interventions also contribute to this long term goal. One of the interviewees mentioned the need for a ministry of Energy to address the energy related issues. This could be a solution. Germany demonstrates there are possibilities to guarantee a long-term feed in tariff. From their practice we know that the feed in tariff had an amazing impact on the upscaling of PV. From Sweden we know the strong effect pricing policy has had on choice of people for alternative energy sources (Coenen 2010).

Experimenting is necessary in order to learn more about drivers and barriers of upscaling. Recently we have seen a lot of emerging theories around the concept of transition management and innovation management, most of which intends to help policy makers to reflect on their options for steering. Still more work needs to be done in this area. Parallel with this study application for policy makers was investigated. This was concluded with a workshop discussing different policy practices in different European countries (Coenen 2010). An important question on the part of policy making is how to involve ‘technology selection’ as part of innovation policy. New technologies would require more support then older ones. Radical innovations need more support then incremental innovation. But how long should you support new technologies? Only development? Or also the application and new business development that is required? Could there be criteria formulated to assess the new technologies on progress? This could help to legitimize the decision to support certain new technologies and no longer some other technologies. What influencing circumstances are legitimate for setbacks on the forecasted development line of a certain technology?

In a time of deregulation it is hard for government to come up with additional rules and regulations. The easiest way would be to simply increase levels of current standards or to change from several more complicated regulations towards a simpler rule. In the aftermath of the credit crunch policy makers will be reluctant to disturb the current market for construction. New or increased standards should not lead to a complete stand still of the sector. On the other hand small steps for more strict regulations could be accomparied by a clear vision on the direction of these small steps in order to create a sense of urgency among the different parties. If the existing building stocks is included in these steps, parties will be allowed time to anticipate and market creation will be stimulated.

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Appendix

Table 4: examples of current activities in the different functions of the innovation system.

Functions	• **Activities**
Entrepreneurial activities	• Commercial forerunners for total concepts, for example organised in Passiefhuis.nl • Experiments in the subsidiary programs UKR and EOS Demo for Passive House experiments • Local municipalities and commercial forerunners with ambitious plans wanting to implement Passive House (e.g. Almere, Eindhoven, Den Bosch)
Knowledge development	• Research programs EOS (e.g. Rigoreus) • Innovation program of PeGO (3 passive house projects) • Building Future cooperation of TNO / ECN / OTB • Research at universities • European and national research studies
Knowledge diffusion	• Toolkits for knowledge diffusion (concept Passive house) • Senter Novem, Milieukeur • Disseminations programs, conferences, fairs and training programs
Guidance of the search	• Political attention for energy use in the building sector • High standards for new building sector (EPC) • Expectations risen by PeGO, a platform organisation with organisations form the building sector (due to innovation program and regulation workgroup)
Market formation	• Covenants (Lente accord, Convenant between building sector, Ministery of VROM) • Consortia (passiefhuis.nl etc) • Areas with ambitious green goals (excellente gebieden) • Meer met Minder (awareness creation, subsidies and professionalisation of the sector) • Lower VAT for reconstruction/isolation etc • Special financial arrangements for green investments (RABObank, ASNbank etc) • Subsidies for components needed in the Passive House concept: PV, heatpumps, solar thermal combinations etc.

Resource mobilisation	• Money for innovation available (see knowledge development)
Support from advocacy coalitions	• Public opinion is changing towards more sustainability • Umbrella organisations as Bouwend Nederland, Uneto VNI, NEPROM, Aedes etc are supporting goals • Environmental NGOs active (f.e. Natuur&Milieu)

Table 5: overview the interventions as indicated by the interviewees

Functions	**Interventions mentioned in the interviews**	**Interventions mentioned in the interviews**
Entrepreneurial activities	• To inform and advise other supply chain parties • Invest in demonstration projects	• Cooperation in the supply chain offering: o coherent information & marketing o one-stop-shop for the client o integrated package of energy measurements, including additional service (f.e. finance) • Find solutions for split incentive (energy & rent combinations)
Knowledge development	• Investing in knowledge development in the supply chain of construction • Training of the people involved • Redevelop process of realisation • Better performing products • Integrated packages in niches • To co-develop instruments for monitoring and evaluation (BREEAM for example) as branche organisation	• Design and developing new products
Knowledge diffusion	• To inform, educate and advise clients on: o the arguments why to invest o the different options available o how the measurements will be like in practice o the measures that suit their situation o what measures can be considered as proven technology & cost effective o their costs and benefits o available subsidies and financial arrangements to implement products and measurements already available • To inform and advise members of branches and create dissemination processes within organisations (Neprom made scheme to promote	• Role of SenterNovem, agency for sustainability and innovation should go beyond energy zero • Stimulate the involvement of maintenance and exploitation costs in investment consideration (education of clients) • To systematically educate end-users of the available options for energy savings (proves to be good for business as well) • Education of the different stakeholders, • Current knowledge should become available for clients of the sector by the different parties involved

	internal dissemination)	

Guidance of the search	• To monitor and evaluate results as branche organisation	• Long term policy goals for the sector
		• Coherent method to balance people, profit, planet & space
		• An independent way to define, to measure and to certify energy efficient houses, with the cooperation of the different parties to actually use these (f.e. real estate agents)
		• An independent way of waying different products and measurements.
		• More regulation is required in the current building sector (from government or EU)
		• EPN could be improved by:
		  ○ equal rewarding of measures, is now sometimes inequal
		  ○ skipping double standards for products
		  ○ energy norms for area's,
		  ○ increase standard levels
		• Installation of a Ministry of Energy to inform, to stimulate, to manage and steer developments across governments of different political preferences.
		• Providing of (independent) information
		  ○ To underpin sense of urgency
		  ○ To provide arguments why it is worth investing in these measures at the moment (needs cooperation of different parties in the entire supply chain, including investors and clients)
		• Financial measures are required
		  ○ Clever financial incentives like those used to stimulate energy efficient cars, for example low VAT rate for energy efficient buildings.
		  ○ Check for contraproductive tax measures
		  ○ Stimulation of green morgages
		  ○ Subsidies should be in place for longer periods, now they hinder sales of energy efficient measures in times these subsidies are put in place
		  ○ The feed-in rate for larger quantities should be insured

Market formation	• Raise awareness with clients • Involve different canals to provide information via internet, DIY shops, real estate agents etc; • Improve communication on the effectiveness of measurements by inventing ways to indicate levels of quality • Integrated concepts and products • Branding total concepts, like Passive	• A general and independent Passive House label for energy efficient buildings to distinguish them from ordinary buildings • To create visibility of parties who do have knowledge

	House • Provide calculation tools to prove added value to potential tools to prove added value to potential clients and building parties	
Resource mobilisation	•	•
Support from advocacy coalitions	•	• To nudge people towards energy saving behaviour should become a subject of discussion • To avoid measures that are out of proportion when problems occur (grey water for example) replace this political reflex by communication on how to avoid these problems